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New membranes boost PEM performance

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The performance of PEM fuel cells is highly dependent upon the proton exchange membrane used. Several fuel cell manufacturers, such as Ballard Power Systems, already produce the membrane materials found in their cells. But some recent work by several researchers has yielded materials with potentially superior properties to those used today.

Not surprisingly, one of a membrane material's most important properties is high protonic conductivity. Early membranes, such as those used in the Gemini space missions, consisted of sulfonated, crosslinked polystyrenes. More recently, interest has turned to sulfonated fluorocarbon polymers, of which DuPont's NAFION(TM) is probably the most popular. This material exhibits protonic conductivity greater than 0.07S/cm.

Recently, work by engineers at Rensselaer Polytechnic Institute (Troy, NY) under grant from Dais Corporation, has resulted in a new membrane material that exhibits the desirable properties of high conductivity and relatively low cost. It's called Dais 585 ionomer, and the core material is a sulfonated styrene/ethylene-butylene/styrene tri-block copolymer, a family which includes such familiar products as Shell Chemical's Kraton(copyright) elastomer.

The end product is said to be an elastic, hydrocarbon based hydrogel with cation exchange ability, good optical transparency, and ion conductivity of 0.09S/cm--roughly 15% higher than competitive materials at 40% lower cost, the company claims.

So far, Dais has incorporated the material into its PowerCell fuel cell products ranging in output from 8 to 100W, and is constructing production-ready prototypes reaching 1 kW.

Another membrane material is being developed by Giner, Inc. (Waltham, MA) for use with the direct methanol liquid feed fuel cell (DMLFFC) invented by researchers at USC and JPL. A drawback of this fuel cell design is that methanol permeates currently available PEMs and passes from the anode to the cathode, resulting in parasitic methanol loss and reduced cell voltage.

To address these issues, Giner patented a composite membrane which has been credited with reducing methanol transmission from 40% to 15% while maintaining high ion conductivity. This project was funded in part by an Army SBIR, and the military is expected to be an early adopter of the DMLFFC.

"The industry has begun bringing engineers in and taking fuel cells from the realm of electrochemists," says Rhett Ross. "Engineers are applying basic engineering techniques to make the materials better."

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